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A PRELIMINARY REPORT AND PROPOSAL FOR THE EVALUATION OF WHEELCHAIR LOADERS FOR PERSONAL VEHICLES

PREPARED FOR
TRANSPORTATION DEVELOPMENT CENTRE

BY
WEST PARK RESEARCH
AND
IBI GROUP

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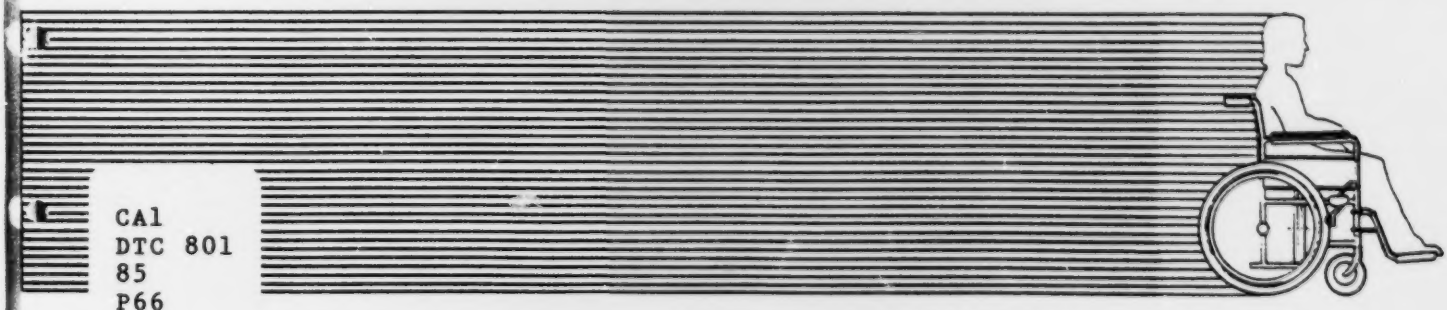

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A PRELIMINARY REPORT AND PROPOSAL FOR THE EVALUATION OF WHEELCHAIR LOADERS FOR PERSONAL VEHICLES

by

J. M. Holden
G. R. Fernie
WEST PARK RESEARCH
UNIVERSITY OF TORONTO
AND
S. Hayto
IBI GROUP

SEPTEMBER 1985

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre.

PROJECT TEAM

West Park Research:

J.M. Holden, MSc,
G.R. Fernie, PhD, PEng
K.R. Lunau, BID
P.J. Holliday, MSc
M.L. Zorzitto, MSc, MD, FRCP(C)

IBI Group:

S.A. Hayto, MASc, MBA, PEng

and

M.L. Young, OTR; Driver Education Program, The Hugh MacMillan Medical Centre, Toronto

Bill Crecco; Crecco's Mobility Systems, Welland

Transport Canada / Transports Canada

Development / Développement

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J.M. Holden, G.F. Fernie, S.A. Hayto et al.

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West Park Research
82 Buttonwood Ave.
Toronto, Ontario
M6M 2J5

IBI Group
240 Richmond Street West
5th Floor
Toronto, Ontario M5V 1W1

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Barbara A. Smith

17. Abstract

This report categorizes, describes and illustrates devices to lift and load wheelchairs and scooters into personal vehicles. Typical users are introduced and the requirements for lifters and loaders are listed. In workshops, consumers and rehabilitation specialists concluded that there is inadequate information available to make appropriate equipment selection. It was also found that there is no means of communicating results of ergonomic evaluations to designers and manufacturers.

A project plan for further research was developed to address these issues. Project objectives include preparation of: a selection and instruction manual for wheelchair loaders; an instruction booklet on methods of manually loading wheelchairs; a design and ergonomic evaluation study; a plan for a public awareness campaign. Tasks required to meet these objectives are described.

This report will be of interest to wheelchair and scooter users, rehabilitation and drivers' education specialists, and equipment manufacturers.

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17. Résumé

Ce rapport classe, décrit et illustre les dispositifs d'embarquement ou de chargement des fauteuils roulants classiques ou spéciaux, à bord des voitures privées. Il donne le profil des différents types d'utilisateurs et précise les caractéristiques techniques exigées correspondantes. En ateliers, des spécialistes de la consommation et de la réadaptation ont constaté que le peu d'information disponible ne permettait pas de faire des choix éclairés et que les moyens faisaient défaut pour rejoindre les projeteurs et les fabricants afin de les informer des évaluations ergonomiques faites sur les matériels qui sortent de leur étude ou de leur usine.

Pour résoudre ces problèmes, un plan de projet a été élaboré, dont les objectifs seraient les suivants: guide de sélection et de maniement des dispositifs de chargement; notice sur le chargement manuel des fauteuils roulants à bord de véhicules privés; évaluation pratique et ergonomique des chargeurs; un projet de campagne publique. Les tâches correspondantes sont décrites dans le rapport qui intéresse au premier chef les utilisateurs et les fabricants de fauteuils roulants classiques ou spéciaux, ainsi que les spécialistes de la réadaptation et de l'apprentissage en conduite automobile pour handicapés.

18. Mots-clés	19. Diffusion
Dispositifs d'embarquement, chargement, aide, fauteuils roulants, rampe, grue, treuil, élévateur, ergonomie, transport pour handicapés	Le CDT dispose d'un nombre limité d'exemplaires

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SUMMARY

Wheelchair users frequently require some assistive device to help them get in and out of vehicles. Sometimes, a wheelchair loader is needed just to lift the wheelchair or scooter into and out of, or on and off the vehicle, and other times the loader must also assist the user in entering and leaving the vehicle.

The range of loaders available was surveyed through scientific and commercial literature. The products were categorized and each type has been described and illustrated.

Workshops involving disabled consumers and rehabilitation specialists were held to define categories of typical users and to match them to the general categories of loaders. The workshop participants also developed a list of requirements for lifters and loaders.

It was determined that there is inadequate information available to consumers and to rehabiliation specialists to allow them to make appropriate selections of equipment. In addition, the need for engineering design and ergonomic evaluation of loaders was identified.

A project plan, developed to address these issues is described. Tasks include the development of an ergonomic tes procedure to determine the abilities and physical strengths required to independently operate a variety of wheelchair loader configurations; the assessment of various "life style" requirements; and an inventory of available wheelchair loading devices.

Based on an analysis of the results of these tasks a set of guidelines will be prepared for the selection and operation of wheelchair loaders. Guidelines will also be prepared on methods of manually loading wheelchairs. Results of the ergonomic evaluation will be made available to designers and manufacturers of equipment for the disabled. Finally, a public awareness program is suggested to provide information and facilitate understanding of the issues.

SOMMAIRE

Les usagers de fauteuil roulant ont fréquemment besoin d'un mecanisme quelconque pour les aider à entrer et sortir de véhicules automobiles. Dans certains cas, seul un dispositif de chargement est nécessaire pour soulever le fauteuil et le charger ou le décharger, alors qu'en d'autres cas, le dispositif doit également aider l'usager à entrer et sortir du véhicule.

L'éventail des dispositifs de chargement disponibles a ete determine a partir de la documentation existante, tant commerciale que scientifique. Par la suite, les produits ont été regroupés en différentes catégories, et chacune a été décrite et illustrée.

Des ateliers, auxquels ont participé des consommateurs handicapés et des ergothérapeutes, ont été tenus afin de définir les catégories d'usagers typiques et d'établir une correspondance entre celles-ci et les catégories générales de dispositifs de chargement. Les participants aux ateliers ont egalement élaboré une liste d'exigences auxquelles ces différents dispositifs devraient satisfaire.

Il a été déterminé qu'il existe un manque d'information adéquate accesible aux consommateurs et aux ergothérapeutes pour leur permettre de faire un choix d'équipment approprié. De plus, il a été constaté la nécessité de procéder à des études techniques et ergonomiques sur les dispositifs de chargement.

Afin de résoudre ces problèmes, un plan de projet a été élaboré. Les travaux viseront le développement d'une procédure d'etude ergonomique afin de déterminer les degres d'habileté et de force physique requis pour opérer de facon indépendante les différents types de dispositifs de chargement; l'évaluation de certaines exigences reliées au "mode de vie"; ainsi qu'un inventaire des dispositifs de chargement disponibles.

Basé sur l'analyse des résultats de ces travaux, un ensemble de procédures sera préparé pour le choix et l'utilisation des dispositifs de chargement des fauteuils roulants, de même que pour la description des méthodes de chargement manuel. Les résultats de l'etude ergonomique seront rendus accessibles aux projecteurs et aux fabricants d'équipment pour handicapés. Finalement, il est suggéré qu'un programme de sensibilisation soit lancé en vue d'informer le public et de l'initier à ces problèmes.

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1. BACKGROUND

1.1 Introduction

A person who needs a wheelchair or motorized scooter for mobility may not be able to lift the chair into his personal vehicle for transport. In this project some of the alternative approaches to answering this need are explored. Solutions range from the use of specialized manual loading techniques (which use leverage to reduce the need to lift) through a wide variety of devices that load chairs into different places in different vehicles.

In this report you will be introduced to a selection of typical people who might need to use a loading device for their chair. You will also learn about the different types of loaders that are available and begin to understand some of the requirements of loading devices. Problems arising in the selection and evaluation process will become evident. Possible solutions to these problems are discussed.

This introductory examination of lifting and loading devices took place over a period of three months. A survey of the scientific literature involved the use of University of Toronto computer facilities to search the engineering, general medical and rehabilitation medicine North American library system databases. In addition, recent journals and indices to paramedical studies were used. The libraries of the Transportation Development Centre and of the Driver's Education Centre, The Hugh MacMillan Centre, in Toronto, were sources of product information. A computer search of Abledata (a USA database of available aids and devices listed in catalogues) and a request for information from approximately 100 manufacturers and suppliers were used as additional resources.

A workshop was held in order to elicit the requirements of loading devices and examine the types of people using such devices. Six consumers were invited to share their experiences and concerns with the project team. These consumers are described in table 1.

A second meeting of the professional team was held to review the classification of loading devices, to discuss a means of rating the present loaders and to develop a strategy for evaluation of devices.

	age	sex	disability	lifestyle	vehicle	chair
1.	40s	M	cerebral palsey	business at home	sedan	scooter
2.	50s	M	high level quadriplegia	professional, civil servant	custom van	electric chair
3.	40s	M	paraplegia	installs loaders	modified van	lightwt manual
4.	37	F	paraplegia	physician	sedan	lightwt manual
5.	54	F	amputations cardiac dis	homemaker	station wagon	lightwt manual
6.	23	F	Charcot Marie Tooth disease (limits motor coordination, endurance)	student	station wagon	scooter

TABLE 1 Characteristics of consumers attending workshop

1.2 Literature

Literature, in general, and resource material on lifting and loading devices is scarce. In recent years a few new resource texts have appeared. The Compendium of Transportation Equipment for Disabled Persons, 1981 (1), contains descriptions and operations of 28 wheelchair platform lift systems (both fold-down and rotary types) for personal and public vehicles. In addition 11 roof, rear seat, trunk and rear bumper loaders are described. A list of manufacturers is provided for the consumer.

Slagle (2), in 1982, outlined the problem of selecting a small car for use by the disabled. He measured 20 randomly selected small and medium sized cars for a guide to vehicle selection. Lewis et al. (3), recently published a guide for measuring vehicle dimensions to determine storage capacity for wheelchairs. Detailed measurements of an extensive list of common 1984 model vehicles are also provided. This was the first of a

series of three publications. The subsequent works (4,5) develop selection guidelines for vehicles and equipment for the elderly and disabled and provide a buyer's guide for consumers. Functional disabilities and driving problems associated with them are outlined. The emphasis is on solutions to actual driving problems, however, the data might be useful in an application to matching persons with lifters and loaders. An inventory of adaptive equipment and suppliers provides a quick source reference for a variety of aids. This includes some lifters and loaders, although no descriptions are provided. A guide to comparing vehicles and summaries of driver assessment, driving instruction and financial assistance programs in Canada make this a practical publication for consumer use.

Several journals publish ongoing news items updating lifting and loading product information for the consumer (6, 7, 8). Paraplegia News (9) produced a description of a variety of devices including manufacturers addresses and a list of the van lifts approved by the US Veterans Administration (VA) in 1982.

Lunt (10) reviews a small selection of backseat, cartop and trunk carriers and ramps. She also describes a method of manually loading a wheelchair into the backseat while sitting in the front passenger's seat.

Reynolds (11) describes a chain driven lift designed to transfer a passenger to the driver's seat of a commonly used tractor. This appears to be in developmental stages since no manufacturer is mentioned. Another design is presented by Hawken et al. (12). An hydraulic hoist lifts the chair into the back seat of a vehicle. The driver's seat has been altered such that it can slide on ball bearing tracks into the space created by the removal of the passenger's seat.

A comprehensive review of standard criteria for wheelchair lift evaluation (13) was based on VA standards. Evaluation criteria included 1) adherence to engineering design and fabrication standards 2) adequacy of manufacturing instruction for installation and operation 3) potential user errors and possible problems 4) ease and convenience of use by disabled persons. The VA standards are currently being updated for the Society of Automovive Engineers in the USA. These standards and recommendations for testing are to be completed within a few months of this present report.

2. USERS OF LOADING DEVICES

It is not within the scope of this study to describe all of the possible combinations of functional abilities and needs of the wide variety of people who could use loading devices for wheelchairs and scooters. We have outlined the circumstances of some typical users with a broad scope of lifestyles, functional ability levels, chairs and vehicles. Although fictitious, these profiles describe people whom one might meet. The typical users have been given names for ease of reference.

Heather, Michael and Mr. and Mrs. Eric (tables 6, 3 and 4) are able to walk but are limited by poor endurance. Alice (table 2) has good upper body strength, while Cameron (table 8) has some coordination problems. David (table 5) depends entirely on his parents and Quinton (table 7), though least able, manages a very active life with a variety of aids.

The busy professionals (Alice and Quinton) have concerns for time and the inconvenience of being blocked in a parking space. The elderly couple (Mr. and Mrs. Eric) do not like to depend on friends, but cannot afford an expensive alternative. The homemaker (Heather) would like to be able to improve her independence but cannot use a loader that will sacrifice cargo or passenger space. The young boy's parents (Mr. and Mrs. David) are having increasing difficulty moving him as he continues to grow. The University student (Michael) and the young professional (Alice) wish they could drive small sports cars.

Age	35 years
Description:	paraplegic, good upper body strength
Lifestyle:	active professional working in downtown office, active social life
Chair:	light weight manual
Vehicle:	2-door mid-sized sedan
Driver/Passenger:	transfers to driver's seat
Present Loading/ Lifting System:	presently transfers to passenger seat and manually folds chair and pulls it into back seat behind passenger seat, then slides across to driver's seat.
Problems:	restricted to mid-sized car due to space requirements. In addition, recently, small and mid-sized cars have been more frequently designed with a console between the front seats which prevents sliding across. As a result she is not able to purchase the red sporty car that she would like to drive. Alice is very dependent on shoulder strength and worries about what will happen if she injures her shoulders and how she will cope when she gets older. In bad weather she is exposed to the elements for several minutes during the transfer and loading process. She is unable to effect the transfer if another vehicle is parked too closely.

TABLE 2 Alice

Age	20 years
Description:	Multiple sclerosis with lower limb function that allows him to walk a short distance, limited upper limb coordination and limited overall endurance.
Lifestyle:	full time university student, active socially, may live in rural setting outside large city centre, lives with his family to try to save money.
Chair:	light-weight manual chair or electric scooter
Vehicle:	small sporty hatchback or 4-wheel drive pick-up truck.
Driver/Passenger:	transfers to driver's seat
Present Loading/ Lifting SLystem	uses crane-type scooter lift for back of hatchback and crane-type chair lift for pick-up truck
Problems:	must back up over the curb to unload, if parallel parking; cannot use lift if another vehicle parks too close to trunk. Experiences some interference with the bumper when unloading the scooter and has dropped it off the attachment bar once creating a fear of accidents. The height of the truck seat above the wheelchair creates difficulty in transferring on days when he is feeling weak.

TABLE 3 Michael

Age	Mid sixties
Description:	Mr.- elderly, stroke, arthritic, cardiac problems Mrs.-elderly, small, weak
Lifestyle	Mr. Eric has been retired for five years and both he and his wife belong to a senior citizens' social club, involving outings at least once a week. The couple does their own shopping, attends church and enjoys driving to a nearby suburb to visit their sons and grandchildren. They depend on a pension and have modest savings to cover unexpected expenses.
Chair:	light-weight or standard manual chair
Vehicle:	4-door mid-sized sedan
Driver/Passenger:	Mr.- transfers to passenger seat Mrs.- drives
Present Loading/ Lifting System	Mrs. loads wheelchair by calling a third person to help because she is unable to lift the chair herself.
Problems	They do not like to depend on others to help them. In fact, sometimes they cannot participate in activities because no one is nearby. They have recently seen a van that has a platform lift but they cannot afford to purchase one and Mrs. Eric is fearful of driving a van.

TABLE 4 Mr. and Mrs. Eric

Age	David 17, Mom & Dad mid fifties
Description:	David- Muscular dystrophy, large, heavy Mom & Dad-not physically fit
Lifestyle	Mom & Dad drive David to school and the family visits friends and relatives each weekend. Occasionally they go out for other activities, such as a visit to the zoo.
Chair:	Sick Children's Hospital electric chair
Vehicle:	van or station wagon
Driver/Passenger:	David rides as a passenger in his wheelchair or is transferred to the passenger seat. Mom & Dad drive and must independently load David plus chair or David then chair.
Present Loading/ Lifting System	van-platform lift or station wagon-crane lift to transfer David; a ramp to load his chair subsequently.
Problems	David is getting very heavy for his parents to move around during transfers, he cannot accurately position his wheelchair on a platform lift for loading without assistance. The chair is heavy and difficult to maneuver up the ramp.

TABLE 5 David and Parents

Age	51 years
Description:	homemaker, two dependent children, bilateral amputee, angina on exertion, respiratory disease she can walk a few steps but can do no lifting
Lifestyle:	manages the home for her husband and children, is involved in social clubs affiliated with the church.
Chair:	light-weight manual chair or electric scooter possibly with oxygen pack
Vehicle:	4-door mid-sized sedan or hatchback or station wagon
Driver/Passenger:	transfers to driver's seat
Present Loading/ Lifting System	depends on third person to load chair
Problems:	restricted in time and level of activity due to dependence on third party to load chair. Would like to have a smaller car to economize on fuel. Cannot afford a second vehicle of any description and therefore her husband must use the same car. Cannot give up a significant amount of cargo space or passenger space to install loading device.

TABLE 6 Heather

Age	47 years
Description:	high level quadriplegic, poor coordination of upper limbs
Lifestyle:	active middle aged professional, attending meetings outside of his downtown office at least once a day. Also active in social and sporting events.
Chair:	electric chair, possibly other devices attached eg. respirator
Vehicle:	van, fully equipped
Driver/Passenger:	drives from chair
Present Loading/ Lifting System	uses radio controlled door opener and lift operator. Drives wheelchair onto lift and raises platform to van height with automatic control. Moves himself, in the chair, to driver's position.
Problems	difficult to align castor wheels with tie down system in driver's position. Because the cold affects his coordination he installed a radio controlled starting system so that he is able to warm up the vehicle in winter before going outside to drive it. It is difficult to find a parking spot with suitable space for side loading. In addition, he frequently has trouble with other cars parked too close to the van for his use of the platform lift on return to the vehicle.

TABLE 7 Quinton

Age	42 years
Description:	cerebral palsy, spasticity and poor coordination
Lifestyle:	runs appliance sales business from his own home, attends meetings outside home.
Chair	manual chair or electric scooter
Vehicle:	2-door mid-sized sedan or hatchback or station wagon
Driver/Passenger:	transfers to driver's seat
Present Loading/ Lifting System	transfers to passenger seat, dismantles scooter, loads pieces into back seat, transfers across to driver's seat.
Problems:	sometimes has difficulty lifting scooter motor over sill of back seat and has to call for help. Cannot load a standard wheelchair independently. A wheelchair is better for sitting long periods in meetings, but a scooter is better for moving long distances. Would like to use a van with a platform lift so he could have a choice of chairs and load either one more easily, however, he cannot afford one. Since it takes 10 minutes to load the scooter using his present system he is greatly affected by weather.

TABLE 8 Cameron

3. LOADERS AND STORAGE DEVICES

Loaders and storage devices have been classified in table 9 according to 1) whether a person and/or a chair is lifted; 2) the type of device used and 3) where in the vehicle they are being placed. Descriptions of typical loaders are presented in figures 1-13.

CATEGORIES OF LOADERS:

Chair/Person	Type of Device	Where Loaded
chair + person	platform elevator (fold-down or rotary)	van side/rear
	portable platform	van side/rear
	hoist	van side/rear
	ramps	auto van rear/side
	special chair/car combo	
person only	hoist	sedan front/rear
chair only (inside)	extending arm	auto, van rear
	docking attachment to door	auto front
	folding crane	trunk
	manual lift assist	trunk
	fixed crane	pick-up truck box
	ramps	auto, van rear/side
chair only (outside)	cartop	on top of any vehicle
	trunk carrier	on rear bumper
	trailer	behind vehicle

TABLE 9 Categories of loaders and lifters

This lift is used in a van, either at the side door or the rear door. A platform, which travels folded in the van, is lowered to allow the person or his helper to move the wheelchair (with seated occupant) onto the platform. It is then raised to the level of the floor of the van and the person or his helper moves the chair into the van . The platform is then folded and stored inside the van for travel. The person either ties his wheelchair to the van floor and remains seated throughout travel (either as a driver or passenger) or he transfers to a seat in the van (that may have a swing around feature). A variety of combinations of radio controlled, automatic, and semi-automatic options are available. Some vans require the modification of roof or floor height to accommodate the user.

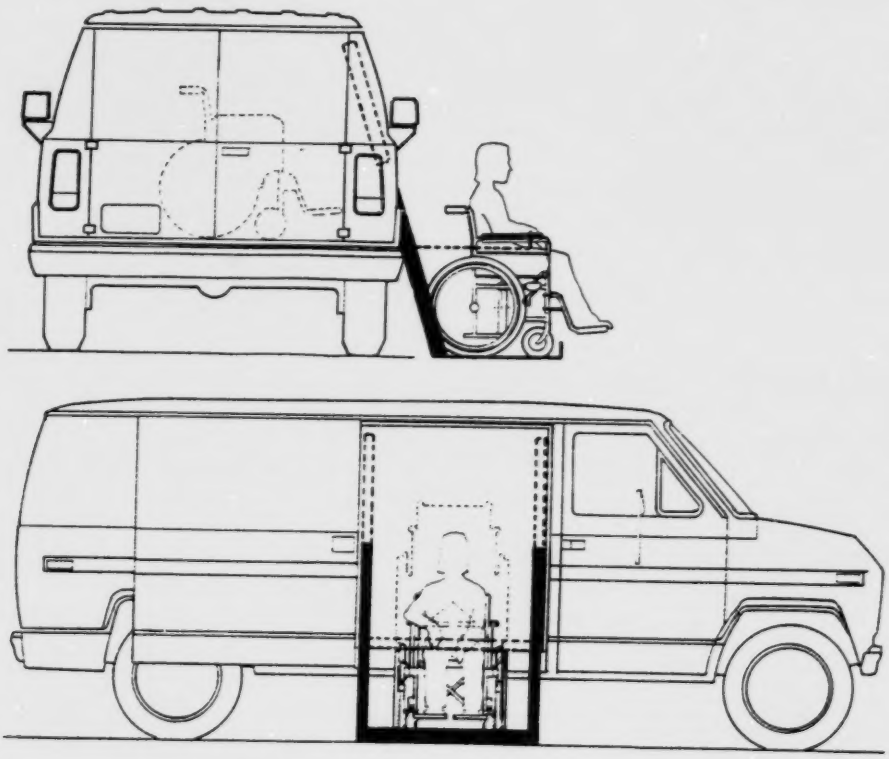

FIGURE 1 Fold-down platform elevator

This is similar to the conventional platform lift in that it is built into the van; however, it swivels through 90 degrees in order to onload and offload the user facing the front of the vehicle. Without this feature the person would have to wheel off the ramp and then turn to wheel away. Thus the swivel platform requires less parking space.

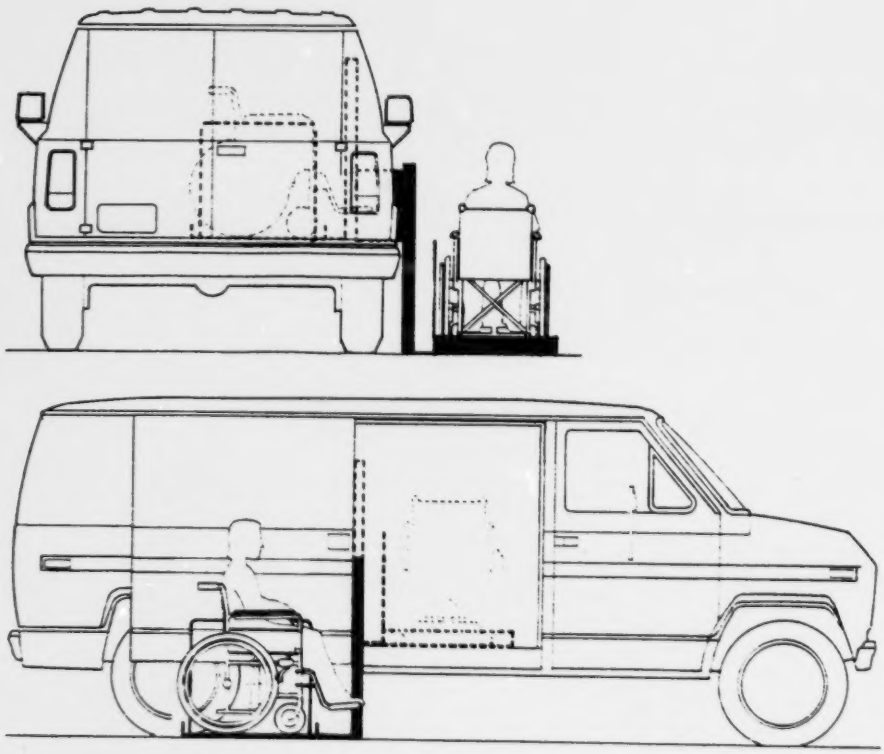

FIGURE 2 Swivel platform elevator

Folded portable platform is positioned beside the vehicle door and raised with an hydraulic foot pump. Compact folding permits easy manouvering and storage in the venicle.

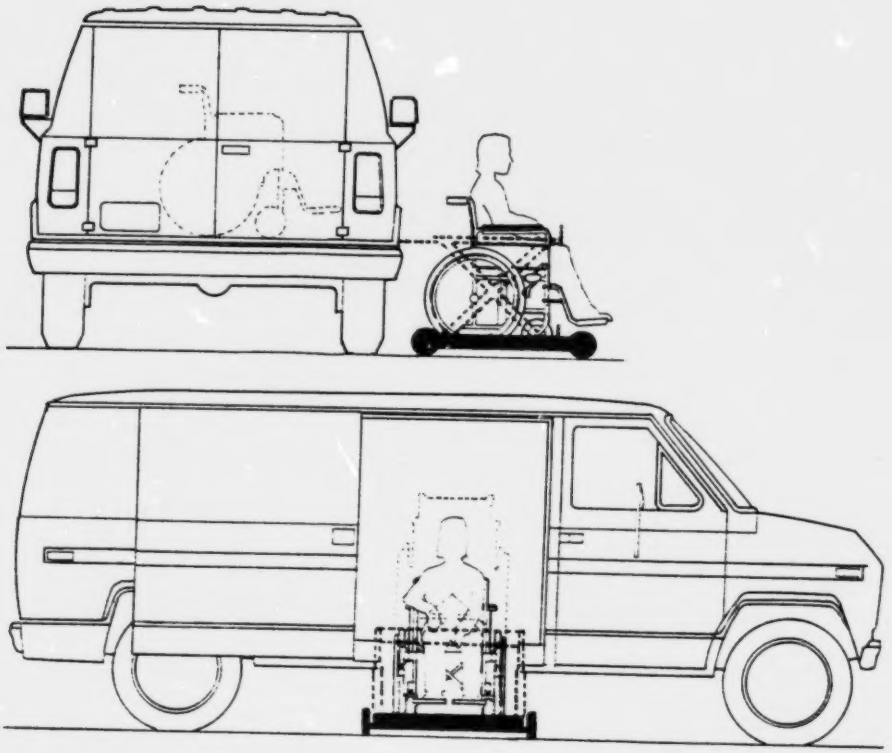

FIGURE 3 Portable platform elevator

This device uses a crane boom that swings in an arc. The wheelchair has rings and ropes tied on to its frame to attach it to the boom of the crane. An automatic device move the crane such that the person/chair assembly is lifted through an arc into the van door. The crane takes up less space than a platform elevator.

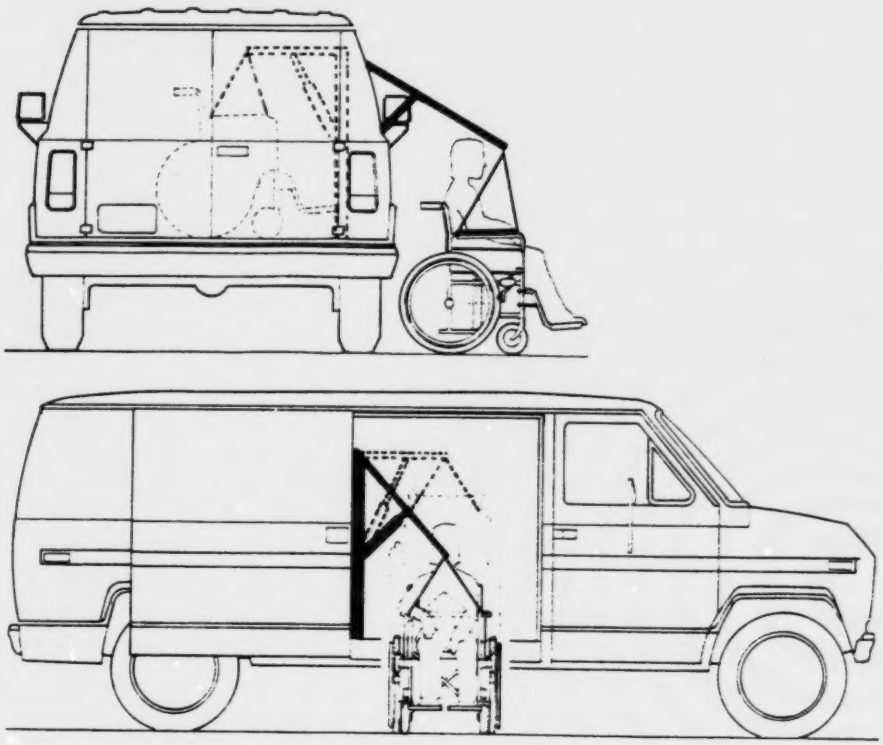

FIGURE 4 Hoist for chair and person

A variety of ramps is available in different materials and sizes. Some of them are suitable for loading a person driving an electric chair and some are only used to load a chair or scooter. Chairs are loaded into the rear of a van, station wagon or car. Ramps can also be used with the side door of a van. The length of the ramp, and therefore its slope, determine how easy it is to load the chair.

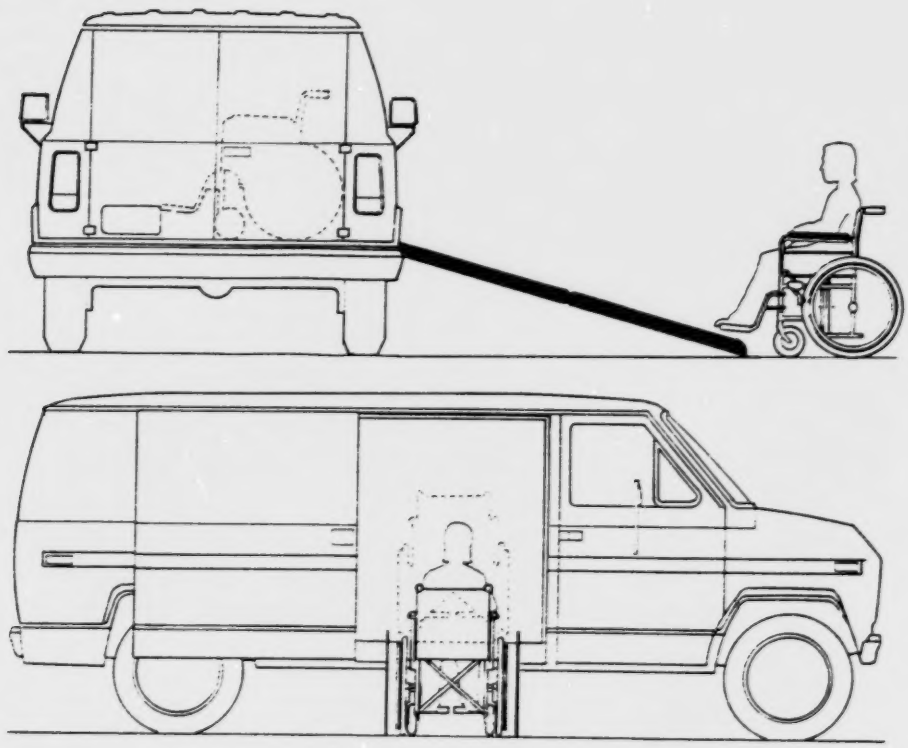

FIGURE 5 Ramps

A variety of new devices have been designed to attempt to eliminate the need to purchase a van with a platform elevator installed. New vehicles that "kneel" to lower the grade of an entry ramp are being developed and improved. In addition some special combinations of crane and scissor arm type lifts are being used to load specialized chairs, designed for that purpose, into the more standard vehicle.

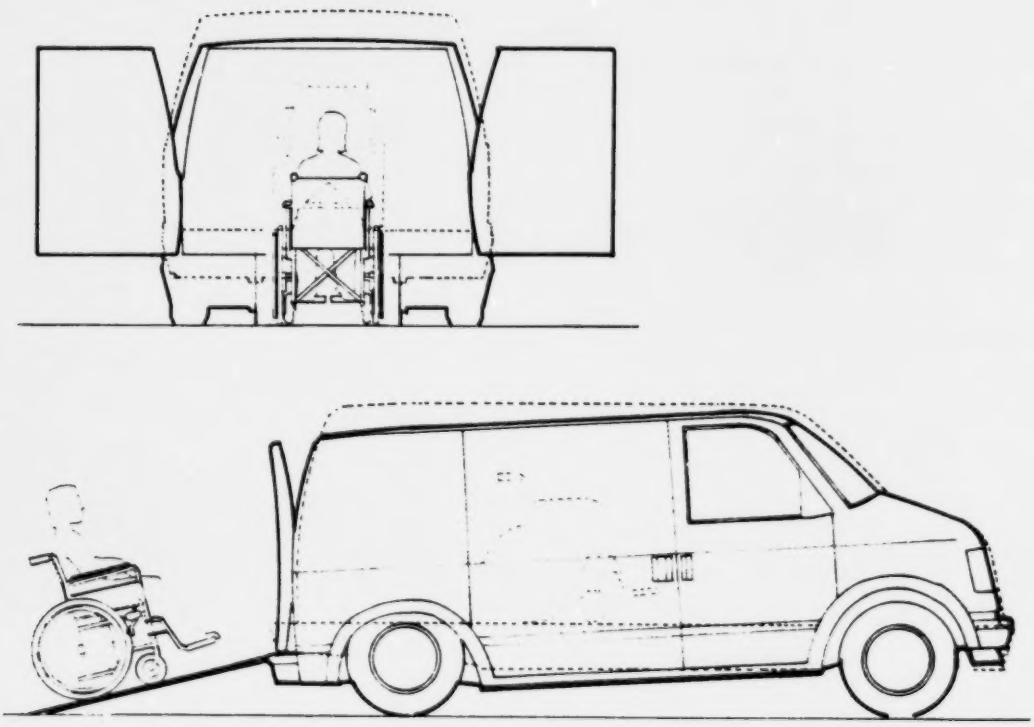

FIGURE 6 Special chairs, special cars

This device usually involves introducing a sling or harness between the person and the chair he is sitting in before the transfer. The sling is attached to the boom of a crane. These cranes can be attached to the door of the vehicle, the roof of the car or may be separately mounted on a rolling stand. The person is then lifted by an hydraulic mechanism operated either by himself or by a helper. He is then positioned over the driver's seat or passenger seat and lowered into position. The crane is then either removed by a helper or the wheelchair user (depending on its type of base) for travel.

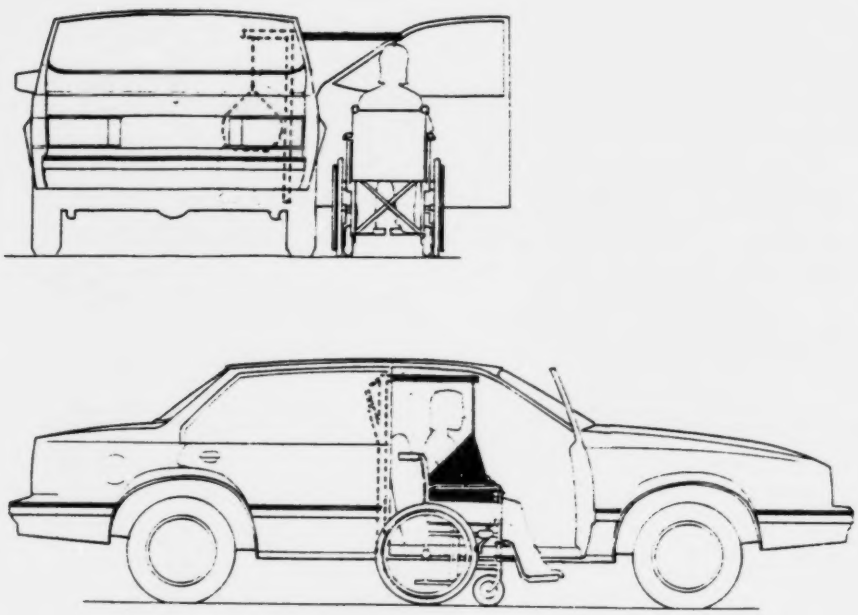

FIGURE 7 Hoist for person only

The wheelchair occupant transfers independently from the wheelchair to the front seat of the vehicle. Then he turns sideways, holding onto a strap or the steering wheel, to fold the chair and operate the mechanism to bring the lifting arm out of the back seat. He positions the lifting device under the seat of the chair and then switches the lifter to automatically place the chair into the back seat compartment.

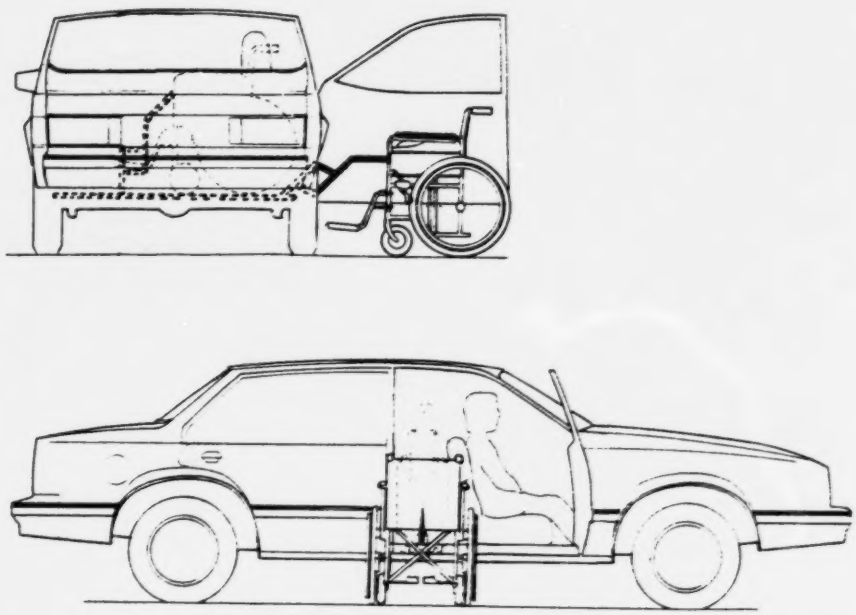

FIGURE 8 Extending arm for rear seat

Car trunk: A scooter is loaded into the trunk of a car using a trunk mounted foldable crane. The scooter may be disassembled before attaching the lifting bar. The consumer must be able to walk from the rear of the vehicle to the driver's seat if used with a car. He must also be able to disassemble the scooter.

Pick-up truck: A similar device is mounted in the box compartment of the pick-up truck and swivels to pick up a chair at the side of the driver's seat. Thus the user can transfer to his truck seat and load the wheelchair independently with no walking required.

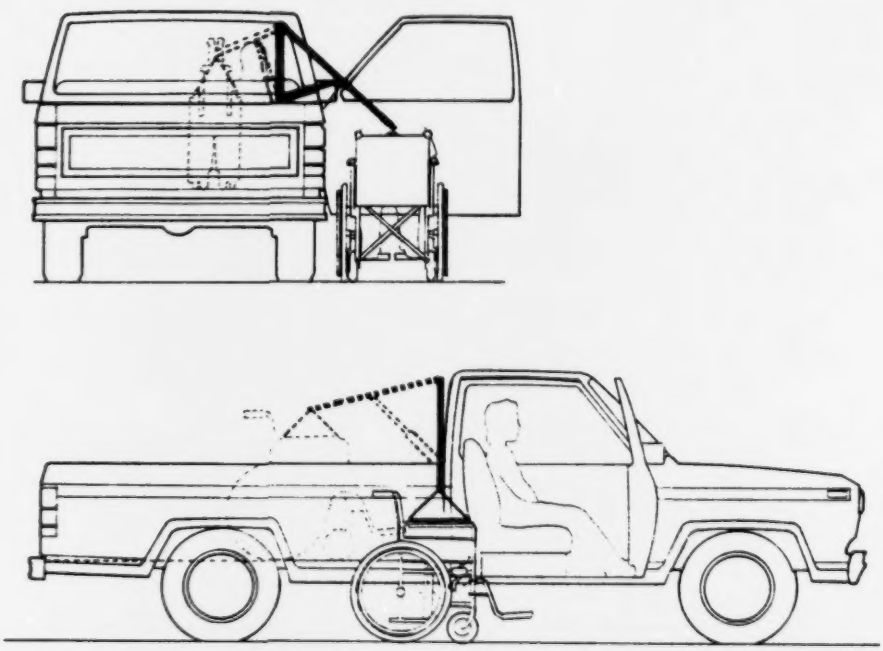

FIGURE 9 Foldable crane for trunk of car or fixed crane for pick up truck

The wheelchair is placed in a holder in the folded position. The person lifts the handle of the loader and swings the chair up and into the trunk with the aid of leverage by the device. This is a manual assist only, and can be used by those who lack the strength to lift a chair into a trunk. The person must be able to walk and coordinate positioning the chair in the device.

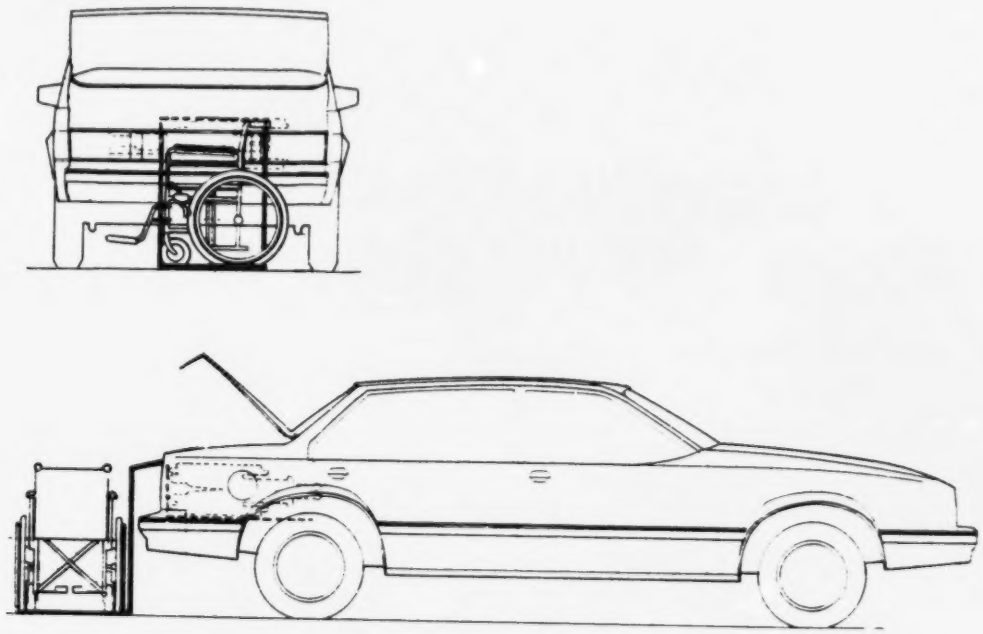

FIGURE 10 Manual lift assist for trunk loading

The user transfers from the wheelchair to the front seat of the vehicle. While holding on to the steering wheel or a strap in the front seat area, he reaches to the side to fold the chair. The attachment bar for the loader is lowered automatically from the cartop compartment and positioned on the wheelchair seat. Then the lifting device is started and the chair is folded and loaded automatically onto the cartop carrier and covered for protection.

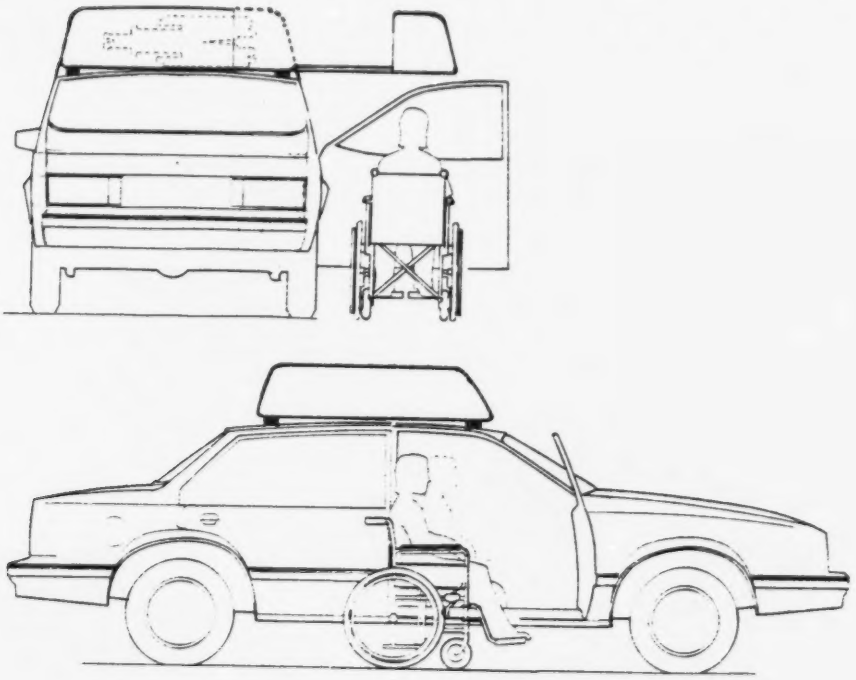

FIGURE 11 Cartop carrier

This device is similar to the carriers one uses for bicycles and other sporting equipment. Some devices tilt for easy loading and some include covers. A high level of functional ability, including walking, is required to load a chair using this device.

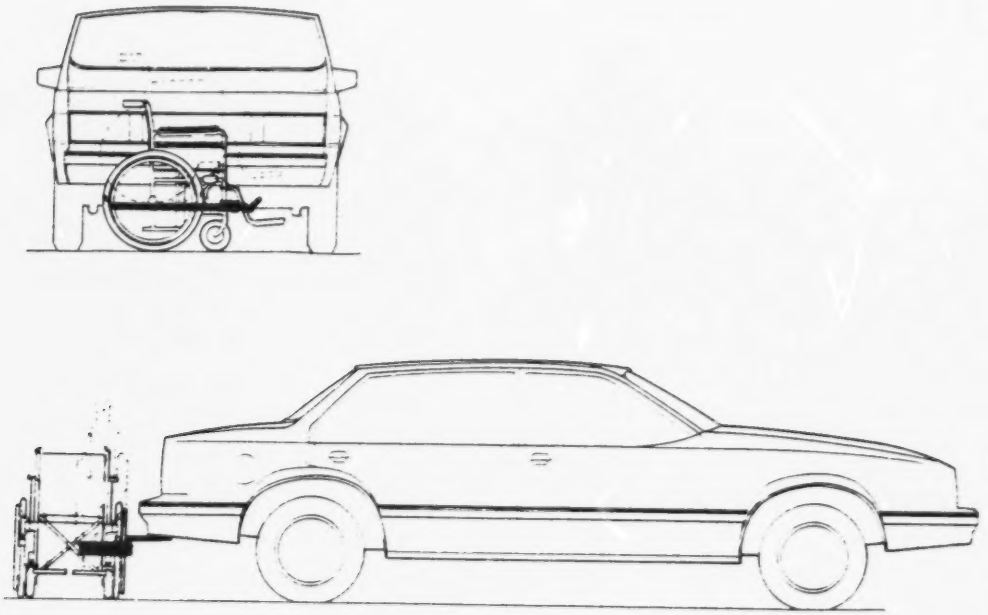

FIGURE 12 Trunk carrier

A small covered or uncovered trailer carries the chair which is loaded using a ramp. A standard trailer hitch is used to attach the trailer to the vehicle.

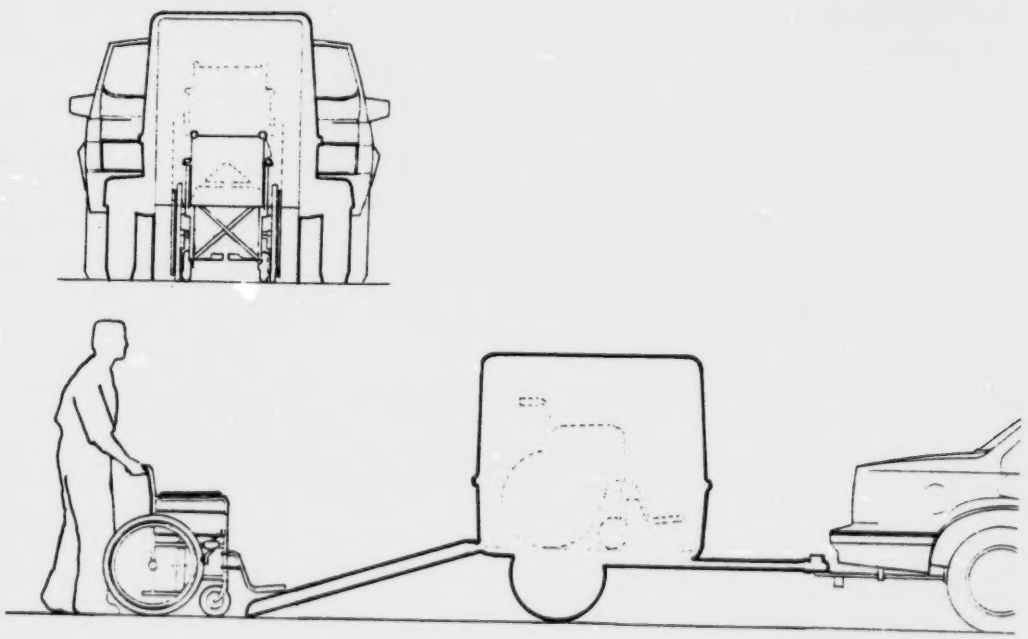

FIGURE 13 Trailer

4. MATCHING USERS AND LOADERS

Some disabled persons are able to use more than one type of device and others may be very limited in their choices. In order to begin to understand whether various consumers' needs could be met, a matrix was developed to match the typical users with the typical loading devices. See table 10. This exercise provided a general means of understanding the matching process and served as a useful method of pointing out its difficulties.

During the workshop, where typical users were matched with some typical devices, it became evident that there was no central source of information on the devices that are available. Most advisors find it difficult, if not impossible, to keep well updated on the characteristics of existing and newly developing loaders on the marketplace. It is particularly difficult in small rural or isolated communities to maintain a large library of information. Therefore, in many cases information is patchy, at best.

Although some manufacturers and distributors are helpful in supplying technical information on their products, they do not include clear guidelines on what functional abilities are required to safely operate the product. The experience of the professionals and the consumers at our workshop indicated that it is difficult for the consumer to guess which devices he might use safely. Many consumers become involved in considerable testing and costly trial and error until a solution is found. In addition, many individuals use a device where simpler specialized manual techniques would have sufficed. Still further examples were cited of people who sacrifice their level of independence simply because they do not have access to information enabling them to select a device that is affordable and appropriate.

Several of the workshop attendants were also concerned with the lack of information on quality of performance of the devices that are available. Consumer evaluation of similar products would facilitate an appropriate selection. Concern was expressed at the absence of certain features and design characteristics from devices. There is no formal mechanism for the communication of feedback from consumers to designers and manufacturers.

	Alice	Eric & wife	Mike	David & Mom	Heather	Quint	Cameron
platform elevator	Y			Y		Y	Y
portable platform elevator		Y		Y			
hoist person + chair	Y			Y			
ramps*	Y	Y	Y	Y	Y		Y
special cars/chairs	Y					Y	Y
hoist person only				Y			
back seat extending arm loader	Y	Y	Y		Y		Y
trunk crane loader		Y	Y		Y		
pick-up truck crane loader			Y				
manual trunk lift-assist		Y	Y		Y		
cartop carrier	Y	Y	Y		Y		Y
trunk carrier		Y	Y	Y	Y		
trailer			Y	Y	Y		

Legend: Y=Yes
*=depends on design matching wheelchair type

TABLE 10 Matrix matching typical users with typical loaders

5. GENERAL REQUIREMENTS OF LOADERS

The requirements of lifting and loading devices developed by consumers and professionals appear in tables 11-17. The ideal loader may not be possible given the current market size and economic constraints. Therefore, each characteristic was rated by the workshop committee as being essential, desirable or optional. Essential parameters absolutely must exist in all loading devices. Desirable features are those that would enhance the ease of use, flexibility, comfort, safety amd availability of loaders. An optional requirement is something nice to have that relates to other less important elements of comfort and aesthetics.

Essential: - fits at least one typical group of consumers

Desirable:
- fits more than one level of function of chair user
- fits more than one level of function of assistant
- fits more than one vehicle
- interchangeable with other vehicles (ie. rentals, friends cars etc.)
- fits more than one type of chair category
- adjustable to fit different body sizes/shapes
- can be operated independently by wheelchair user
- does not require specially designed chair

Optional: - none

TABLE 11 Matching of the functional abilities of the user with his/her chair/scooter and a vehicle

Essential:	- within the physical capability of at least some users
Desirable:	- easy to operate, user friendly - easy to operate in weather extremes - accommodates different lifestyles (rural, urban, homemaker, business) - instills confidence in the user, ie. perception of safety - does not take up useful cargo space
Optional:	- remote control option available

Table 12 Ease of operation requirements

Essential:
- must prevent significant injury or death
  - in use, when person is in wheelchair during loading:
    - safety device to prevent overload
    - device to prevent falling (rails, ledges)
    - safe tie down system for person plus chair
    - CSA/UL/VA approval
    - prevention from folding at inappropriate time
    - no obvious hazard for injury in traffic during offloading
    - flap to prevent feet catching between lift platform and van
    - flap to prevent wheeling out of van when lift platform is in down position after offloading another passenger
  - all lifts: no obvious hazard for hands or other body parts
  - out of use, all lifts:
    - does not obstruct vision
    - is well fastened to avoid injury during impact
- must prevent significant functional damage to the wheelchair:
  - does not handle chair abusively
  - protects from significant environmental damage

Desirable:
- must prevent cosmetic damage to property
  - does not damage chair through handling or environmental damage
  - does not damage vehicle through handling or environmental damage
- must prevent inconvenience to user
  - has back-up system if power mechanism fails
  - function is not affected by bad weather

Optional:
- none

Table 13 Safety Requirements

Essential:	- none
Desirable:	- requires no extra space to park vehicle - offers a choice of installation for backloading or sideloading - offers a choice of entry from side or back with a single loading device - offers choice of parking underground (roof height) - offers choice of installation on driver's side or passenger side (where applicable, eg. back seat loaders)
Optional:	- none

Table 14 Parking Requirements

Essential:	Purchase price:	- must be affordable to at least one typical group of users
Desirable:	Purchase price:	- affordable to more than one typical group
	Installation:	- avoids the need to change vehicle
		- minimize modifications to vehicle required
		- can be installed by the user
		- if not user installable then installation facilities are available nearby
		- price is affordable to at least one typical group
	Maintenance	- durability matches high user activity level
		- easy to maintain
		- parts readily available and price relates to original cost of device, ie. component costs are not significantly greater than the original cost
	Depreciation of vehicle	
		- minimized the loss
		- in resale value of the vehicle
		- re changes to vehicle
		- re damage to vehicle
	Running cost	- minimize increased fuel consumption resulting from drag (if mounted outside vehicle) and extra weight.
Optional:	- none	

Table 15 Cost Considerations

Essential:	- reliable and easy to maintain. Design and manufacture must be in accordance with sound engineering principles
Desirable:	- manufacturer of the device has a proven track record in making and servicing loaders or similar devices
Optional:	- none

Table 16 Reliability and continued servicability requirements

Essential:	- none
Desirable:	- none
Optional:	- must be unobtrusive, compact, stylish

Table 17 Aesthetic requirements

6. PRESENTLY AVAILABLE LOADERS

Information on the devices available was collected from a variety of sources: distributers, manufacturers, prescribers, an installer and published literature. A considerable amount of data has been collected and more is being received each day. A brief description of loaders for which we have some information is appended (Appendix A) in order that the reader may gain some understanding of the variety of devices available. Complete information and details of all devices was not received by the time of this report, in spite of the fact that the first task accomplished in this project was the widespread request for detailed product information. In addition, as discussed earlier, information concerning what functional requirements are appropriate for use of a specific device is not available from any source.

7. REQUIREMENTS FOR AN EVALUATION OF WHEELCHAIR LOADING DEVICES

7.1 Issues and Problems

A number of important issues were identified during the workshop sessions on wheelchair loaders.

7.1.1 Functional Abilities

There is a lack of understanding of the functional abilities that are required to:
-load a chair manually;
-load a chair with a mechanical assistance and
-load a chair and occupant with mechanical assistance.

7.1.2 Product Information

There is a lack of readily available information on prices, specifications and characteristics of loading devices available in the marketplace. Manufacturers, distributers and installers are not well known to the disabled community.

7.1.3 Impact of Loaders/Lifters on Lifestyle

There is a lack of information on the way that each loading device impacts on the user and the vehicle. For example, cargo or passenger space may be reduced because of the installation of the device. There may be extra parking space requirements, specific chair type requirements and problems created by severe weather conditions that should considered before purchase. In addition, the installation of a loader may cause difficulties for other drivers/passengers of the vehicle.

7.1.4 Matching User and Loading Technique

There is a general lack of understanding and widespread knowledge of the process of matching a user

with a loading device and/or loading technique. At present, this issue is only addressed by very few consumers, advisors, installers and funding agencies.

7.1.5 Engineering and Ergonomic Evaluation

There is a lack of detailed information on the engineering and ergonomic aspects of performance of wheelchair loaders on the market. As a result potential design improvements have not been identified.

7.1.6 Public Awareness

There is a lack of awareness of the general public with respect to the needs of wheelchair users and their parking requirements. There is also a need for safety precautions by other drivers when driving close to vehicles that might be offloading a wheelchair and occupant.

7.2 Objectives of Study to Address the Issues

In view of these problems it is clear that there is a fundamental need for further study to address these issues. The study might have the following objectives:

7.2.1 Functional Abilities

Identify the level of function required by the wheelchair user to use:
- -devices to load wheelchair only;
- -manual loading techniques and
- -devices to load chair and occupant.

7.2.2 Product Information

Compile a computerized data base on wheelchair loaders in a form that will facilitate annual updating.

7.2.3 Impact of Loaders/Lifters on Lifestyle

Compile a list of factors that impact on lifestyle requirements of users for:

- -devices to load wheelchair only;
- -manual loading techniques and
- -devices to load chair plus wheelchair.

This will include weather, parking space, passenger space, cargo space and use of the vehicle by other drivers.

7.2.4 Matching User and Loading Technique

Develop a selection process for matching the needs of wheelchair users with the various types of wheelchair loaders and produce it in a format that is easy to use by consumers, installers, advisors and funding agencies. This will result in the production of three manuals :

- -device selection and instructions for loaders of wheelchairs only
- -selection and instructions for manual techniques (no devices)
- -device selection and instructions for loaders/lifters of chairs and occupants

7.2.5 Engineering and Ergonomic Evaluation

Evaluate selected wheelchair loaders in terms of quality of performance measures such as: cycle time, safety features, mechanical and ergonomic suitability, etc. Potential design improvements will be identified.

7.2.6 Public Awareness

Outline the information needed by the TDC in order to develop a public awareness campaign to improve attitudes and behaviour relating to parking of wheelchair users. This includes the design of materials for a brochure and production of a short video tape.

8. PROJECT PLAN FOR EVALUATION OF WHEELCHAIR LOADING DEVICES

8.1 Introduction

A study to address these issues could be divided into a series of tasks. There are two ways that the study could be designed. One approach would be to start with objective one and assess all the functional abilities required for all the devices. This would be followed by information gathering and so on until all the objectives were met. This approach would not generate an instruction and selection manual that could be used by wheelchair owners until at least objectives 1-4 are satisfied.

A second approach would be to go through steps one to four for the devices to load chairs only and produce a manual. While that document is being used by consumers, research could be continuing in the development of the other two instruction and selection booklets, namely for manual techniques and for devices which load the chair and the person together. With this approach, the consumer would have some of the results of the study in a practical form earlier. This second approach has been used in developing the tasks that follow.

TASK 1 Develop a selection and instruction manual for loaders for wheelchairs.

TASK 2 Develop a selection and instruction manual for manual techniques of loading wheelchairs.

TASK 3 Develop a selection and instruction manual for loaders of wheelchairs with their occupants.

TASK 4 Fully evaluate the engineering and ergonomic design factors of selected loaders.

TASK 5 Prepare information for a brochure and a video tape for the general public on safety, parking and courtesy.

8.2 Task 1: Develop a Selection and Instruction Manual for Wheelchair Loaders

8.2.1 Select and Acquire Loaders for Testing

8.2.1.1 Types of Loaders

Devices to be studied include:
- extension arm system for back seat;
- folding crane for trunk;
- manual lift assist for trunk;
- cartop carrier and
- trunk carrier.

8.2.1.2 Acquire Loaders

Sources of loaders for temporary use include:
- loan from manufacturer or distributor;
- rental from distributor/manufacturer;
- use of subjects' own installed and operating loaders and
- purchase and resale.

8.2.2 Select subjects for testing

8.2.2.1 Subject Sample

A full ergonomic evaluation of the devices would require a large sample of subjects due to the wide range of disabilities, lifestyles and sizes of the target population. It is therefore recommended that the study be undertaken as a series of case studies of one person chosen from each of the groups that are able to use each type of device. This would include 6 subjects testing the five loaders for a wheelchair only.

8.2.2.2 Subject Characteristics

Pertinent details regarding medical condition will be collected by questionnaire. Age, height and anthropometric data will be recorded. Pinch strength, handgrip strength and upper limb strength will also be measured. Standard neurological tests will be done to assess upper limb and trunk sensation and coordination.

Lower limb function and sensation will be tested where applicable. Sitting balance and transfer mobility will be assessed. Range of motion tests will be done to determine limitations.

8.2.2.3 Subject Honorarium

Heinemann et al., 1985, in a study of subjects for physiological testing, found that quality of response from subjects was improved by compensating them for participation in an experiment. Our experience has shown that subjects are more likely to take their contribution seriously when compensated. When not reimbursed for inclusion in studies, subjects are more likely to drop out of a study part way through trials, a problem which inevitably costs more in staff salaries for retesting subjects than if the subjects has been paid for their time in the first place.

8.2.3 Locate Test Site

Potential sites include:
- government facilities;
- automobile dealership facilities and
- rehabilitation institute garage facilities.

8.2.4 Study Functional Abilities Required To Use Loaders

8.2.4.1 Ergonomic Test Procedure

This test will be designed to determine what functional abilities are necessary to independently operate a particular type of loader. Each of the subjects will evaluate each of the relevant loading devices (see table 10). Hence 24 combinations of subject category and loading category will be tested. The operation of loading and unloading with each device will be broken down into defined sequential tasks, thus isolating different movements required. Each subject will rate each task on a linear analogue scale.

very easy	moderately easy	neither easy nor difficult	difficult	impossible

Failure to acheive a requisite task by a subject will cause the researchers to critically examine the circumstances and to determine if the result was likely to be representative for this category of subject. If so, then the matrix of table 10 would be modified.

Tasks that are rated by any of the subjects to be difficult will be examined. The purpose will be to determine the most critical tasks for each of the categories of users.

8.2.4.2 Biomechanical Measurements

The relevant physical requirements (reach, range of motion, force, torque) for these tasks will be measured and documented to provide standards against which prospective users' abilities can be evaluated. Force and torque measurements will require the design of biomechanical measuring instruments. Whenever possible the physical requirements will be compared to an easily understood activity for comparison. For example, the force required to pull a seat forward may be similar to that required for pulling a standard door open.

8.2.5 Study Lifestyle Factors

8.2.5.1 Questionnaire

Subjects will be asked about the following lifestyle requirements:

- weather considerations,
- cargo requirements,
- passenger requirements,
- other driver's use of the same vehicle,
- specific chair requirements,
- parking requirements ie. height, width, length of parking space restrictions.

8.2.5.2 Measurements

The representative loaders will be assessed for the amount and location of parking space required for their safe use. The cargo or passenger space relinquished by using each device will also be measured. Time taken to effect ingress and egress of the vehicle will be measured for each subject to provide a means of comparing devices.

Subjects will comment on how each loader would impact on their lifestyle requirements. A summary will be made of the lifestyle considerations that cannot be accommodated by each loader. This information will be presented in easy to use tables for consumer reference.

8.2.6 Collect and Tabulate Information Required for Purchasing and Installing Loaders

Purchase price range, approximate installation price and approximate maintenance costs will be tabulated for each device where possible. Tables matching the types of loader with different types of vehicles and chairs will be prepared to assist selection for a person who cannot afford to change his vehicle or chair. The impact of availability of installation and maintenance facilities will also be discussed.

All loaders found to be available will be researched for data to complete the database as listed in Appendix B. These items were developed as desirable for an information index for all types of users: consumers, installers, prescribers and advisors. This material, including the results of the functional tests will be presented in matrix format for easy reference and comparison. The data will be stored and manipulated using a common commercially available data base software package such as dbase III.

In addition, a list of advisors, installers, distributors, manufacturers and funding agencies will be compiled.

8.2.7 Design and Print Manual for Selection and Instructions for Use of Loader

A simple set of instructions will be developed to assist a consumer in the method of use of this information in the selection of a loader. The only task remaining is

to develop a computerized information index of all the loaders and their characteristics for ease of updating.

8.3 Task 2 Develop a Selection and Instruction Manual for Manual Techniques of Loading Wheelchairs

8.3.1 Select Manual Techniques

There are four commonly used methods of loading a wheelchair without the use of a loader:

load chair into back seat while sitting in front passenger seat;
load chair into back seat while sitting in front driver's seat;
load chair into back seat while standing outside vehicle and
load chair into trunk while standing outside vehicle.

Widespread knowledge of these techniques might prevent the unnecessary purchase of a mechanical device. In addition, these carefully thought out methods use physical principles which reduce the amount of work done compared to an inefficient method of lifting.

8.3.2 Select Subjects for Testing

There are five subject groups that might make use of some type of manual technique. One person will be selected to represent each of these groups for case study purposes. Subjects will be measured in a similar manner to task 1.

8.3.3 Study Functional Testing, Lifestyle Factors and Preparation of Manual

Tests and measurements for functional ability, lifestyle requirements and the development of the matching procedure will be carried out similar to task 1. There will be no need to collect information on equipment because none is used, however, there will be a summary note advising consumers on how to find appropriate occupational therapy, physical therapy and nursing assistance, where necessary.

8.4 Task 3: Develop a Selection and Instruction Manual for Loaders of Wheelchairs with Their Occupants

8.4.1 Select and Acquire Loaders for Testing

The loaders will be acquired using the methods outlined in task 1. Devices to be tested will include:

- platform elevator-fully automatic, swinger type;
- platform elevator-semi automatic, fold down type;
- portable platform elevator;
- hoist for wheelchair and occupant;
- ramp for wheelchair and occupant.

8.4.2 Select Subjects for Testing

Subjects from seven categories will be selected for testing in a manner similar to task 1. This will mean 18 combinations of subject and loader.

8.4.3 Study Functional Abilities, Lifestyle Factors, Information Collection and Development of Manual

All other aspects of this study will be similar to task 1. It is especially interesting to study the possibility of using the portable platform and the person plus chair hoist because these are less expensive alternatives to the standard van elevators. In addition, there is a need to determine if the portable elevator might be an inexpensive alternative for relatives or friends of a disabled driver for use on occasional trips in a vehicle which does not have an expensive elevator system installed.

8.5 Task 4: Design and Ergonomic Evaluation Study

One of the observations of our workshops was the need to develop improved loading devices. An effective way of stimulating their development would be a detailed design/ergonomic evaluation of devices that are of potential value but are found in tasks 1 and 3 to have some deficiencies. This phase will involve considerably

more intensive ergonomic and engineering evaluation of systems. The detailed protocol of this phase will be developed in the light of experience gained and in accordance with the Canadian Standards Association recommendations and the shortly forthcoming recommendations of the Society of Automotive Engineers in the USA. Some discussion with our American colleagues at this time would avoid duplication of effort.

One or more reports of evaluations of specific, commonly used products will be published. These reports will be in a form that will be of value to designers and manufacturers since they will not only contain critical comment but will also include suggestions of ways to improve the product.

8.6 Task 5: Public Awareness

Information will include:
- a description of some of the typical users of loading devices;
- a general description of the types of loaders;
- examples of how these loaders imply the need for more parking space and safety consideration;
- where to go to get help in selecting an appropriate loader.

This material would be available for inclusion in a brochure that could be distributed to the general public. Drawings and photographs will be included wherever possible to facilitate widespread understanding of the issues.

In addition, a brief video tape will be made to be used in public displays. This would include examples of people using different types of devices. Some typical problems and dangers in parking and traffic situations will also be highlighted.

REFERENCES

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APPENDIX A PRESENTLY AVAILABLE LOADERS

Loads Person Plus Chair:

Platform Elevators

Number:	1
Company name:	Apener Naschinenbau Und Forderanlagen
Product name:	Hubnatik Swivel Lift
Canadian distributor:	Yes
Country Manufactured:	Germany
Approx price:	$ 3800 (Canadian Funds)
Features:	Can be installed in either rear or side van doors, swivels 90 degrees and lowers tc pavement. Fully automatic.

Number:	2
Company name:	Braun
Product name:	Lift Away Semi Automatic and Automatic
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	The platform, which is stored in a vertical postion move through an arc to the horizontal and lowers vertically to the pavement. Available in fully automatic or manual folding versions. Several safety features are included.

Number:	3
Company name:	Braun
Product name:	Swing-a-way Lift
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	Swings 90 degrees outside door of van and lowers vertically to pavement. Various safety devices are standard.

Number: 4
Company name: Crow River Industries Incorporated
Product name: Vangater
Canadian distributor: Yes
Country Manufactured: United States
Approx price: $2000-$2500 (U.S. Funds)
Features: Available in fold down platforms or swing platforms.

Number: 5
Company name: Collins
Product name: Saf-t-lift
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Folds down from vertical storage postion. Lowers vertically to pavement.

Number: 6
Company name: Collins
Product name: Swing-Lift
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Swings through 90 degrees and lowers to road surface.

Number: 7
Company name: Drive-Master Corporation
Product name: Gateway Lift
Canadian distributor: Yes
Country Manufactured: United States
Approx price: $ 2000 - 3000 (U.S. Funds)
Features: Platform is split centrally and folds, first vertically outside the van and then swings into a vertical postion inside the doors. Available in fully automatic and semi-automatic options for side and rear mounting.

Number: 8
Company name: Golden Boy Sales of Canada Limited
Product name: Canadian Swinger
Canadian distributor: Yes
Country Manufactured: Canada
Approx price: $2700-$2800 (Canadian Funds)
Features: Swings through 90 degrees and lowers vertically to pavement.

Number: 9

Company name:	Target Industries Incorporated (Intex)
Product name:	Target T 500, Falcon FX 700
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	$2000-$3500 (Canadian Funds)
Features:	Very clean design folds down, available with a wide range of options including, automatic, semi-automatic and various remote contol options.

Number: 10

Company name:	Jure Limited
Product name:	Savaria
Canadian distributor:	Yes
Country Manufactured:	Canada
Approx price:	?
Features:	Split folding platform with vertical storage.

Number: 11

Company name:	Mobility Engineering and Development Incorporated
Product name:	?
Canadian distributor:	?
Country Manufactured:	United States
Approx price:	?
Features:	Electrically operated - Unfolds from vertical to horizontal and lowers to road surface vertically.

Number: 12

Company name:	Para Industries Limited
Product name:	Mark II
Canadian distributor:	Yes
Country Manufactured:	Canada
Approx price:	?
Features:	Fully automatic platform unfolds from vertical postion to horizontal and lowers to road surface.

Number: 13
Company name: Ratcliff Tailifts
Product name: Welfare Lift
Canadian distributor: No
Country Manufactured: England
Approx price: 1200
Features: Platform flat stores vertical and unfolds to the horizontal and lowers to the pavement.

Number: 14
Company name: Reb Manufacturing Incorporated
Product name: Two in One, and Semi Automatic
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: Fold out platform in either electro hydraulic or semi automatic gravity lift.

Number: 15
Company name: Ricon
Product name: R50, R30
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: Fold out platform available in fully automatic or semi automatic all electric.

Number: 16
Company name: Ricon
Product name: Rotary Wheelchair Lift
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: Rotates through 90 degrees and lowers to pavement.

Portable Elevators

Number: 18
Company name: CN Unwin Limited
Product name: Unwin QuickLift
Canadian distributor: No
Country Manufactured: England
Approx price: 350
Features: Portable platform is unfolded and a hydraulic foot pump is used to raise the platform to van floor height the device folds into a compact package which can be loaded into the vehicle.

Hoists for Side or Rear Van Doors

Number: 17
Company name: Handicaps Incorporated
Product name: Super Arm Lift
Canadian distributor: No
Country Manufactured: United States
Approx price: ?
Features: Frame of wheelchair is attached by rings and heavy ropes to hook on the end of a crane like boom. The crane, mounted in the floor of the van, moves through an arc to lower the chair from van to pavement.

Loaders Requiring Special Car/Chairs

Number: 19
Company name: Car Chair Limited
Product name: Car Chair
Canadian distributor: No
Country Manufactured: England
Approx price: ?
Features: This device requires a specially designed chair which is loaded into the front driver or passenger seat. The chair is positioned so that the back of the chair is against the side of the car with its door ajar. A mechanical arm lifts the entire wheelchair and person and rotates through 90 degrees to position them including their chair inside the car.

Loads Chair Only

Extending Arm for Rear Seat

Number: 20	
Company name:	Amigo
Product name:	Amigo Auto Lift
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	This conversion requires that the entire backseat of the automobile be removed and recarpeting be done. In addition, the rear door of the sedan must have its hinges reversed to open towards the trunk of the car. A crane type lift is mounted inside the backseat area and lifts the scooter into the space behind the front seat automatically.

Number: 21	
Company name:	Independant Living Aids
Product name:	Anthony's Auto Wheelchair Lift
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	The extension arm reaches out from the backseat area and lifts the wheelchair into its storage position behind the drivers seat.

Number: 22	
Company name:	Bruno Independant Living Aids
Product name:	Insider II
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	Similar to Anthony's Auto Wheelchair Lift and has options for use with a van or auto.

Number: 23
Company name: Wright-Way Incorporated
Product name: Wright-Way Wheelchair Loader
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Similar to the Anthony Auto Lift

Docking Attachment To Front Door

Number: 24
Company name: Wisco
Product name: IMP II
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: The wheelchair is attached to a docking system on the inside of the open front door. The person transfers to the front seat and then in automatic retrival system lifts the chair into storage position, the chair is secured in place and the door is then closed.

Folded Crane for the Trunk

Number: 25
Company name: Amigo
Product name: Amigo Scooter Lift
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: Trunk floor mounted crane is used to lift disassembled scooter.

Manual Lift-Assist for the Trunk

Number:	26
Company name:	Easy-One-Corporation
Product name:	EZ-1
Canadian distributor:	?
Country Manufactured:	United States
Approx price:	$ 219.00 (U.S. Funds)
Features:	This a simple loading rack with linked arm extensions that assist in the manual removal and loading of a folded manual wheelchair.

Crane Loaders for Box Compartment of Pick-up Truck

Number:	27
Company name:	Wright-Way Incorporated
Product name:	Wheelchair Pick-up Loader
Canadian distributor:	?
Country Manufactured:	United States
Approx price:	?
Features:	Crane type loader is mounted in the box compartment of a pick-up truck the folded chair is lifted into the truck.

Ramps

Number:	28
Company name:	Braun
Product name:	Wheelchair Ramps
Canadian distributor:	Yes
Country Manufactured:	United States
Approx price:	?
Features:	Hinged manually folding ramp has spring to counter balance. Can be installed in rear or side doors. Also available a telescoping ramp with separate guides for each wheel track.

Number: 29
Company name: Chair Carrier Products Incorporated
Product name: Travel Ramps, Van Ramps
Canadian distributor: No
Country Manufactured: United States
Approx price: $110-$135 (U.S. Funds)
Features: Variety of fiberglass ramps in one piece or sectional pieces for portable use in moving a chair from one level to another anywhere and also for specialized use with vans.

Number: 30
Company name: Collins
Product name: Econo-Ramp
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Mounted on base of van floor. Hinged to fold at van entry and half way down extended ramp. Steel construction.

Number: 31
Company name: G.W. Medical Supplies and Equipment
Product name: Folding Aluminium Wheelchair Ramps
Canadian distributor: Yes
Country Manufactured: Canada
Approx price: $300 -$320
Features: Small light weight ramps with seperate section for each wheel section, available in six or eight foot lengths folds for storage.

Number: 32
Company name: C.N. Unwin Limited
Product name: Handiramp
Canadian distributor: No
Country Manufactured: England
Approx price: 140-300
Features: Ramps telescope to 1 metre, 2 metre or 3 metre lengths. They are light weight and have seperate tracks for each wheel guide. Suitable for manual or electric chairs. Photo shows person in chair.

Number: 33
Company name: Wright-Way Incorporated
Product name: Wheelchair Ramp
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Available in portable and permanent designs. Seperate tracks for each wheel.

Loads Outside Vehicle

Car Top Carrier

Number: 34
Company name: Arthur Bailey Pty Limited, Top Cat Limited
Product name: Wymo Electric Hoist for Wheelchairs, Top Cat
Canadian distributor: ?
Country Manufactured: Australia, United States
Approx price: ?
Features: Folded chair is lifted automatically to wire grid car top base and is secured with a bungee cord with no external cover.

Number: 35
Company name: Braun
Product name: Chair Topper
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: Folded chair is lifted automatically and is stored in a completely fiberglass cover.

Number: 36
Company name: Chair Caddy Incorporated
Product name: Chair Caddy
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Similar to Braun Chair Topper

Number: 37
Company name: Carters Limited
Product name: Chair-Up
Canadian distributor: No (U.S.)
Country Manufactured: England
Approx price: ?
Features: Folded chair is lifted automatically and stowed on a masonite roof base. It is automatically covered by a heavy plastic fabric type case.

Number: 38
Company name: Intex
Product name: Dotson Chair Caddy
Canadian distributor: No
Country Manufactured: United States
Approx price: ?
Features: Similar to the Braun Lifter

Number: 39
Company name: Top Cat Limited
Product name: Top Cat
Canadian distributor: No
Country Manufactured: United States
Approx price: $1600.00 (U.S. Funds)
Features:

Number: 40
Company name: Wheelchair Carrier Corporation
Product name: Mark VII Electromatic Top Loader
Canadian distributor: ?
Country Manufactured: United States
Approx price: $1300.00 (U.S. Funds)
Features: Similar to Braun Loader

Number: 41
Company name: Wright-Way Incorporated
Product name: Car Top Carrier
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Similar to Braun Carrier

Trunk Carrier

Number: 42
Company name: Nelson
Product name: Trujillo Industries Electric Wheelchair Carrier
Canadian distributor: ?
Country Manufactured: United States
Approx price: ?
Features: Uncovered electric chair travels sideways behind the trunk of the vehicle. Sturdy arms extended from beneath the rear bumper to support a split ramp which is extended and tilted to the pavement for easy loading and unloading. An optional plastic weather cover is available.

Number: 43
Company name: ABCO
Product name: Pack-all Wheelchair Carrier
Canadian distributor: Yes
Country Manufactured: United States
Approx price: ?
Features: A simple rear bumper rack allows the chair to be tilted to load the casters first. Then it is manually lifted such that the rear wheels are positioned on a second portion of the rack. An extendable restraining cord is used to secure the chair. No cover is shown.

Number: 44
Company name: Sogimpex
Product name: Wheelchair Rack
Canadian distributor: Yes
Country Manufactured: Canada
Approx price: ?
Features: The rack is folded in the trunk and removed to attach manually on the rear bumper. The chair is lifted on en-masse onto the rack tray and is secured in place with stretchable straps.

Number: 45
Company name: Wheelchair Carrier Incorporated
Product name: Tilt-N-Tote
Canadian distributor: No
Country Manufactured: United States
Approx price: $220.00 (U.S. Funds)
Features: Permanently mounted from the rear bumper and tilts so that a wheelchair can ce easily wheeled into position and tilted upright to travelling position. A plastic cover is available.

Number: 46
Company name: Nelson
Product name: Wheelchair Carrier
Canadian distributor: ?
Country Manufactured: United States
Approx price: $100.00 (U.S. Funds)
Features: Similar to the ABCO Pack All Wheelchair Carrier described earlier.

Trailor

Number: 47
Company name: G.W. Medical Supplies and Equipment
Product name: Tagger Wheelchair Trailer
Canadian distributor: No
Country Manufactured: United States
Approx price: $950.00 (U.S. Funds)
Features: Covered trailer attaches on standard trailer hitch. Has built in ramp with non-skid surface. Available without cover.

Number: 48
Company name: Chair Carrier Products Incorporated
Product name: Chair Trailer
Canadian distributor: ?
Country Manufactured: United States
Approx price: $800-$2600 (U.S. Funds)
Features: Covered trailers for a variety of styles of chairs. No further details available.

APPENDIX B DATABASE FOR INDEX OF EXISTING LOADERS

Number

Name of Device:

Manufacturer:

Distributor:

Price:

Function of loader
- loads user then chair
- loads user plus chair
- loads chair only
- loads user only
- stores chair only

Type of chair loaded
- standard manual
- lightweight manual
- electric chair
- electric scooter
- specially designed manual
- specially designed electric
- none

Type of vehicle used
- sedan (subcompact, compact, full sized)
- lift back (subcompact, compact, full sized)
- station wagon
- mini-van
- full sized van
- pick up truck
- specially designed vehicle

Doors
- 2-door
- 4-door
- side door
- rear door

Where loaded

car driver seat
passenger seat
back seat (wheelchair folded)
back seat (chair unfolded
cartop
outside trunk
inside trunk
behind car

station wagon (not included above)
back door of station wagon

van
side door
back door

pick up truck
box compartment

Driver/Passenger transfers and seating position

Drives
from wheelchair
transfers to car seat

Passenger only
travels in wheelchair
transfers to passenger seat

Safety features included

while in use
cannot be overloaded
prevents falling eg -railings
-ledges, guards
limited risk of injury in traffic
has safe tie down system for person + chair
prevents injury to hands
and other body parts
does no damage to chair (handling, environment)
does no damage to vehicle
has back-up system if power fails
function not impeded by weather conditions

while out of use
does not obstruct vision in storage position
well fastened to avoid injury during impact

Manual for selection of loaders for wheelchairs

Introduction and directions for use of manual
Description of devices
Photographs demonstrating operation of device
Description of case study subjects (for ease of identifying with the closest person to consumer's actual description)
Functional requirements
matrix

Device	1	2	3	4	5
able to walk	x			x	
able to pull seat forward		x			
able to lift 20 pounds					x
grasp strength x pounds			x		
etc.					

Lifestyle factors
matrix

Device	1	2	3	4	5
passengers					
1					
2					
3					
4					
cargo space reduction					
x cubic meters					
y cubic meters					
effect on other drivers					
no adjustments needed					
moderate adjustments					
special chair required					
scooter					
lightweight chair					
small chair					
parking space required					
height					
x meters					
y meters					
width					
x meters					
y meters					
weather					
easily used in rain					
snow					
cold					
heat					
time to load 1-2 min					
3-5 min					
6-10 min					
11-20 min					

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